STS and Electrophoresis Equipment Verification Test

Payload Integration Plan

October 15, 1979

National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas

REVISIONS

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STS AND ELECTROPHORESIS EQUIPMENT VERIFICATION TEST PAYLOAD INTEGRATION PLAN

LIST OF EFFECTIVE PAGES

BASELINE 10/15/79

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PAYLOAD INTEGRATION PLAN

SPACE TRANSPORTATION SYSTEM

AND

ELECTROPHORESIS EQUIPMENT VERIFICATION TEST

OCTOBER 4, 1979

APPROVED:

NASA/JSC/SPIDPO

for Space and Life Sciences Director

PREFACE

This Payload Integration Plan (PIP) represents the payload-to-Space Transportation System (STS) agreement on the responsibilities and tasks that directly relate to the integration of the payload into the STS, and includes a definition of the tasks that the STS considers optional services.

Upon provision of the required funding by NASA Headquarters STS Operations, the identified optional services will be implemented according to the PIP schedule.

Further understanding of the STS operations and the associated payload-unique requirements may indicate the need for addition or deletion of optional services. This can be accommodated by amendment of the PIP and provision of funding by NASA Headquarters STS Operations. The official commitment for the launch date is reflected in the NASA Headquarters flight assignment. The launch date shown in this PIP is for planning purposes only.

CONTENTS

1.0 INTRODUCTION

The National Aeronautics and Space Administration (NASA) plans to launch an Electrophoresis Equipment Verification Test (EEVT) with the Space Transportation System (STS).

For purposes of this Payload Integration Plan (PIP), the STS shall be represented by the NASA-Johnson Space Center (JSC) and the NASA-Kennedy Space Center (KSC). The EEVT shall be represented by the JSC Space and Life Sciences Directorate (SLSD).

This plan provides the management roles and responsibilities, and a definition of the technical activities, interfaces, and schedule requirements to accomplish the integration, launch and activation of the EEVT with the STS.

2.0 MANAGEMENT RESPONSIBILITIES

The responsibility for assuring the definition, control, implementation, and accomplishment of the activities identified in this document for the STS is vested with the Shuttle Payload Integration and Development Program Office (SPIDPO) at NASA-JSC and for the EEVT with the SLSD.

2.1 Joint Responsibilities

The STS and the SLSD will support the necessary integration activities, both analytical and physical, identified in this plan and according to the schedules contained in section 15.

2.1.1 Documentation.- The documentation for insuring proper integration of the payload will consist of the PIP and PIP annexes.

These documents and associated changes will be jointly approved by STS and SLSD. Configuration control will be initiated upon signature approval. NASA/JSC will maintain configuration control of the above documentation in accordance with Change Control Requirements and Procedures Manual JSC 13995, with the exception of the Launch Site Support Plan Annex which will be maintained by KSC.

2.1.2 Reviews.- The reviews that will be implemented to assess the EEVT implementation process will be the Shuttle Mission Reviews plus the Flight Readiness Review (FRR) as defined in the Shuttle Payload Integration Plan, JSC 14363.

2.2 STS Responsibilities

NASA/JSC SPIDPO is responsible for integration of the EEVT into the STS including analytical and physical integration, integrated flight design, integrated flight operations, and compatibility with other cargo elements which share the same flight.

NASA/KSC is responsible for the STS launch and landing support, for agreed-upon facilities and services required for integrated checkout, and for ground integration of the EEVT and STS.

2.3 SLSD Responsibilities

The SLSD is responsible for the design, development, test, performance and safety of the EEVT, mission support, and for providing airborne and ground support equipment to KSC, as well as providing verification of EEVT compatibility with the Shuttle vehicle.

3.0 PAYLOAD DESCRIPTION

The Electrophoresis Equipment Verification Test (EEVT) is intended to verify the electrophoresis equipment as appropriate hardware for use in separating individual functioning biological cells and large molecules. The equipment, shown in figure 3-1, includes an electrophoresis unit, cryogenic freezer for the biological cells, a camera system, and a tape recorder for on-orbit data collection which will be stored in the middeck locker areas.

The EEVT configuration is shown in figure 3-1. Configuration drawings and data will be provided by SLSD as part of the Payload Data Package Annex (Annex 1).

4.0 MISSION OPERATIONS

The flight operations summary requirements and constraints by flight phase are as delineated in subsequent paragraphs of this section.

4.1 Preliminary Mission Scenario

The EEVT support equipment is to be packed and stored in the locker at KSC prior to installation into the Orbiter. Final servicing of the freezer unit and the electrophoresis unit is required prior to installation. After achieving orbit the EEVT will be activated by the crew in the middeck area, the data collected, and the support equipment stored prior to entry. Upon landing the EEVT locker will be removed from the Orbiter and turned over to the appropriate SLSD personnel.

4.2 Orbital Requirements and Payload Control Parameters

The EEVT is independent of orbital altitude, inclination, flight profile etc. Operation of the EEVT is preferred to be at 10^{-3} g load or less. Any maneuvers or excursions greater than this, during a test run, should be noted.

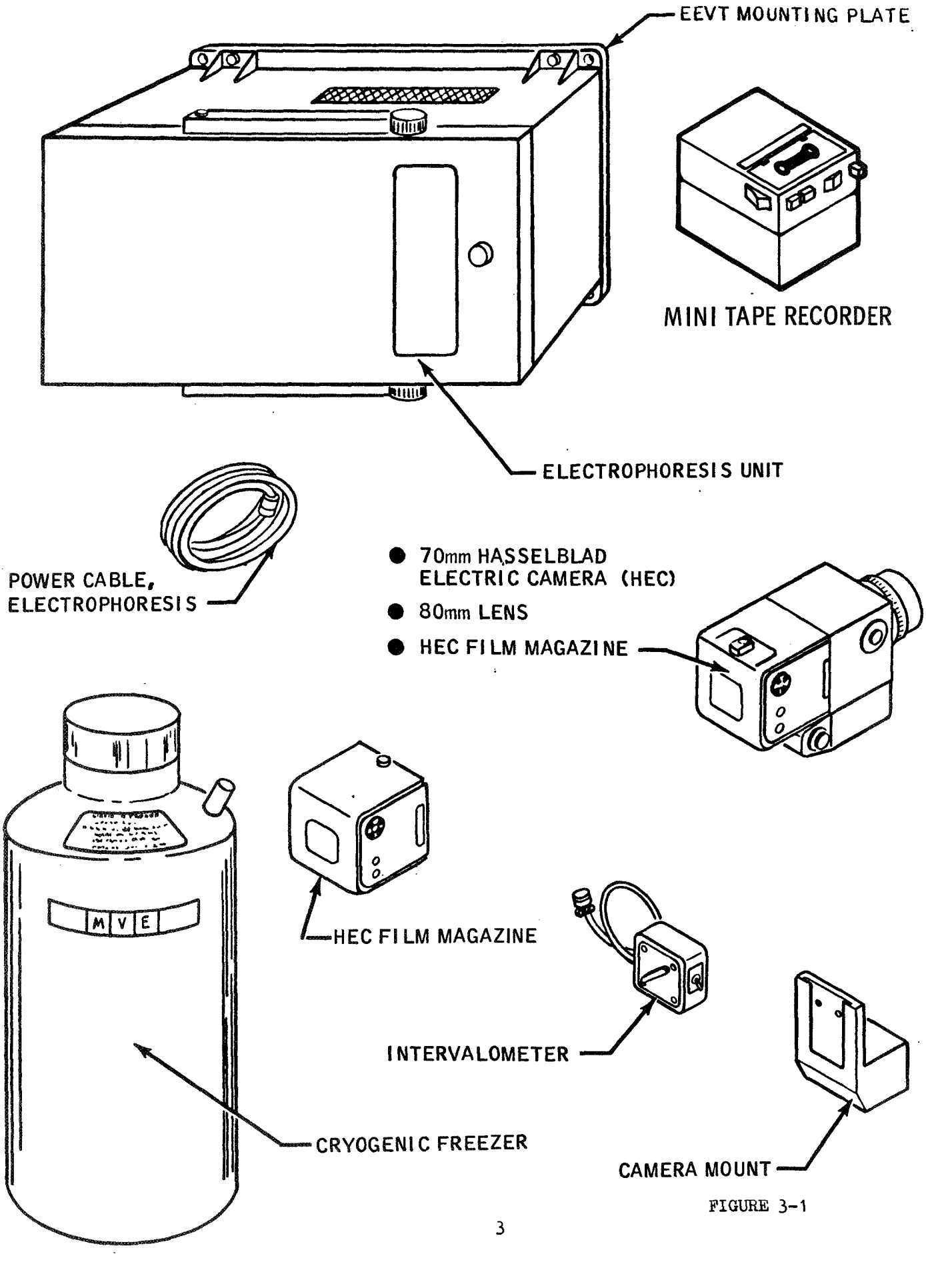
EEVT MOUNTING PLATE
MINI TAPE RECORDER
ELECTROPHORESIS UNIT
POWER CABLE, ELECTROPHORESIS
● 70mm HASSELBLAD ELECTRIC CAMERA (HEC)
● 80mm LENS
● HEC FILM MAGAZINE
HEC FILM MAGAZINE
INTERVALOMETER
CRYOGENIC FREEZER
CAMERA MOUNT

FIGURE 3-1

EEVT CONTROL WEIGHT - 90 lbs (40.9 Kg)*
EEVT CONTROL ENERGY - 2.25 Kw H

The term "control weight" and "control energy" as used in this PIP is the maximum weight which the Cargo may not exceed without STS concurrence.

The EEVT sequenced mass properties and configuration drawings will be provided by the SLSD as part of Payload Data Package Annex.

4.3 Operational Requirements and Constraints

The following EEVT operational requirements and constraints will be used in the flight planning.

4.3.1 Prelaunch.- Servicing of the electrophoresis unit and the freezer and final packing of the samples will be performed prior to installation into the Orbiter. Final installation of the electrophoresis unit and the locker will be accomplished at 20 hours prior to launch or less.

4.3.2 Ascent.- No operation required during ascent.

4.3.3 On-Orbit.- One crewmember is required to (1) set-up the experiment with camera and tape recorder, (2) insert electrophoresis column and sample slide, (3) set panel switches, and start camera and tape recorder during the electrophoresis time (45, 60 or 75 minutes), the crewmen can do other activities. At the end of the electrophoresis time the crewman (1) freezes the column in place, (2) removes the column and inserts into freezer, (3) inserts a new column, (4) inserts a new slide and repeats the procedure, (5) reloads the camera and tape recorder as required, and (6) restore and repack the EEVT locker prior to reentry. The handling time from the end of electrophoresis time to start the next one is approximately 30 minutes. Eight columns are required which would make crew activity total 2.5 to 4.0 hours. Detailed requirements are reflected in paragraph 8 of this PIP and Annex 2.

4.3.4 Descent.- No operation required during descent.

4.3.5 Postlanding.- The EEVT locker is to be removed within 3 hours after landing. The freezer will require servicing prior to shipment to JSC.

5.0 EEVT-TO-STS INTERFACES

The STS mechanical and electrical interfaces are defined in the Orbiter Crew Compartment Annex. The environmental interfaces with which the EEVT must be compatible are defined in the "Environmental Requirements and Test Criteria for Orbiter Vehicle; MF00014-014, Rev C," par. 3.3.3.

*Includes locker, cable, and mounting plate.

5.1 Structural/Mechanical Interfaces

The structural/mechanical interface between the EEVT and the STS are defined in the Orbiter Crew Compartment Annex. The EEVT consists of a locker and associated packaging for storage of the camera, tape recorder, freezer, ac power cable, and a mounting plate with standard attach fittings for the electrophoresis unit.

5.2 Cable Interfaces

The SLSD will provide an ac power cable to interface with an utility outlet as defined in par. 5.4.

5.3 Display and Control Interface

The EEVT displays and controls are located on the EEVT unit and are defined in the crew compartment Annex (Annex 6).

5.4 Electrical Power Interfaces

The EEVT shall utilize 115 V ac, 400 Hz, 3 phase power from a convenient utility outlet.

Electrical power interface requirements are as follows:

Power Source	On-orbit only
Orbiter bus	178 W

The specific power profile will be defined by the SLSD in the flight planning annex (Annex 2).

5.5 Command Interfaces

No command interfaces utilized.

5.6 Telemetry and Data Interfaces

No telemetry and data interfaces utilized.

5.7 Fluid Interfaces

No STS fluid interfaces required, however, the EEVT will utilize 178 watts/hr which dissipates ~ 608 BTU/hr to cabin air. The total operating time of the EEVT is 12 hours.

5.8 Orbiter GPC Software Services

No GPC software services utilized.

6.0 ENVIRONMENTAL ANALYSIS AND INTERFACES

The EEVT shall meet the natural and induced environmental interfaces including structural loads, thermal, contamination, shock, vibration and acoustics and are contained in the Environmental Requirements and Test Criteria for Orbiter Vehicle; MF0004-014 Rev C, par. 3.3.3.

Since the EEVT has previously flown on the ASTP, the physical and functional environmental compatibility of the EEVT with the Orbiter will be shown by similarity. The environmental compatibility will be documented in the verification compliance matrices (VCM). The SLSD is responsible for providing this verification and is to cover the following environments:

Structural loads
Thermal environment
EMI/EMC
Contamination
Shock, Vibration and Acoustic
Environment
Ground Environment

6.1 Structural and Loads Deflection

Requirements to be verified per paragraph 6.0 above.

6.2 Thermal Environments and Interfaces

Requirements to be verified per paragraph 6.0 above.

6.3 EMI/EMC

Requirements to be verified per paragraph 6.0 above.

6.4 Contamination

Requirements to be verified per paragraph 6.0 above.

6.5 Shock, Vibration, and Acoustic Environments

Requirements to be verified per paragraph 6.0 above.

6.6 Ground Environmental Requirements

Requirements to be verified per paragraph 6.0 above.

7.0 INTEGRATION HARDWARE

Responsibilities for the integration hardware is defined in the following paragraphs:

7.1 STS-Provided Hardware

The STS will provide a locker and associated packing material for the EEVT.

7.2 Payload-Provided Hardware

The SLSD will provide the electrophoresis mounting plate with attach fittings and the ac power cable.

8.0 FLIGHT OPERATIONS

This section defines the flight design, flight activity planning, flight crew and flight controller training and flight operations support activities required for EEVT/STS integration.

8.1 Flight Design

There are no unique flight design requirements for the EEVT.

8.2 Flight Activity Planning

8.2.1 Crew Activity Plan.- The STS will be responsible for all crew activity plans and will develop an integrated summary and detailed STS/EEVT crew activity plan to support the flight. Included in the plan will be the SLSD supplied payload sequence of events. SLSD will provide this sequence as part of the flight planning annex (Annex 2).

8.2.2 Payload Operating Procedures.- SLSD is responsible for the development and verification of payload operating procedures. The payload operating procedures are transmitted to the STS via the Flight Operations Support Annex of the PIP (Annex 3). These procedures will be used by the STS to generate the integrated STS/payload procedures.

8.3 Training

SLSD is responsible for providing payload discipline training including briefings on experiment objectives, science background, and EEVT systems to the crew and STS flight controller personnel. STS will be responsible for providing all other crew and flight controller training. SLSD will provide the payload training requirements and training schedule inputs in the Training Annex (Annex 7).

8.4 Flight Operations Control

STS is responsible for the conduct of on-orbit payload operations. EEVT flight operations will be conducted from on board the Orbiter by the flight crew supported by the NASA/JSC Mission Control Center (MCC) when ground coverage is available using the Spaceflight Tracking and Data Network (STDN). The STS flight control operations will be conducted from the MCC. All payload activities will be coordinated with and supported by the STS in negotiated periods of time and within the capabilities and constraints of the Orbiter. SLSD will provide a representative at the JSC POCC during EEVT flight operations. Display of available Orbiter downlink data and intercom to Payload Officer will be available in the POCC. The basic plan, timelines, and agreements for the attached operations, including necessary procedures, will be identified in the Flight Operations Support Annex (Annex 3).

8.5 Command and Control Support

The voice interface required between the POCC and the Payload Officer will be used to respond to crew comments on the operation of the EEVT.

9.0 LAUNCH AND LANDING SITE SUPPORT

EEVT payload launch and landing site support requirements and test and checkout requirements will be defined by the JSC Space and Life Science Directorate (SLSD) and provided to and negotiated with the LSSM for assessment and KSC support commitment. These requirements will be expressed in KSC Standard Universal Documentation System (UDS) and Operations and Maintenance Requirements and Specifications (OMRS) formats provided by KSC. These requirements will be integrated by KSC and SLSD with the Shuttle and support organizations for procedures development and requirements implementation.

9.1 EEVT Prelaunch Operations

The EEVT flight hardware and associated GSE will be received into and processed in the Operations and Checkout (O&C) Building, room (TBD), according to the processing plan contained in Annex 8, Launch Site Support Plan. SLSD will perform prelaunch checkout and servicing of EEVT elements utilizing procedures which have been reviewed by KSC for safety. Typical prelaunch checkout and servicing activities include: 1) electrical checkout

of the electrophoresis unit, 2) cryogenic freezer checkout and top-off, and 3) EEVT preparations for installation in Orbiter. No EEVT activities are planned in the VAB.

9.2 Pad Operations

The electrophoresis unit and the EEVT locker will be installed in the Orbiter cabin while on the pad at T-20 hours or less. Test, checkout and interface verification activities will be conducted according to test and checkout requirements and procedures as approved and documented in the PIP Annex 8.

9.3 Postflight Operations

Access will be required to the Orbiter cabin within 3 hours following landing at Edwards AFB to remove the EEVT locker for disposition by SLSD. The EEVT electrophoresis unit will be returned to KSC in the Orbiter for postmission deintegration by KSC/SLSD. Servicing of the EEVT freezer is required prior to shipment to JSC. The above requirements are specified in the Launch Site Support Plan Annex (PIP Annex 8).

9.4 Aborted Flight

If an aborted flight lands at the KSC Shuttle Landing Facility (SLF) the payload will be removed and the EEVT returned to SLSD.

In the event that an aborted flight lands at the secondary or contingency landing site, SLSD should be prepared to accept the payload at the landing site after removal from the middeck due to the limited ferry capability of the Shuttle Carrier Aircraft. If the cargo is within the ferry capability and associated safety requirements and is compatible with associated environments it will be returned to KSC in the Orbiter.

10.0 SAFETY

The JSC SLSD (Space and Life Sciences Directorate) is responsible for assuring that the EEVT and its GSE (ground support equipment) are safe. The EEVT and GSE shall be designed to comply with the requirements of NASA Office of Space Flight document NHB 1700.7, "Safety Policy and Requirements for Payloads Using the Space Transportation System (STS)," dated May 1979, particularly paragraph 216 concerning reflown hardware. To assess compliance with the safety requirements one safety review will be conducted by the STS in accordance with JSC 13830, "Implementation Procedure for STS Payload Safety Requirements," May 1979.

The safety documentation required to support the safety review shall be provided by the payload organization 30 days prior to the scheduled safety review. The results of the safety review and assessment will be the safety certification of the EEVT and GSE by the SLSD prior to delivery, start of processing, and installation in the Orbiter. The SLSD will submit a flight readiness statement for the EEVT at the flight readiness review.

11.0 INTERFACE VERIFICATION

The SLSD is responsible for verifying compatibility with the interfaces and environments specified in this PIP.

It is anticipated that this interface verification will be accomplished within the scope of normal test, checkout and integration flow of the EEVT.

12.0 POSTFLIGHT DATA REQUIREMENTS

a) G levels from rate gyros and/or IMU sensors during thruster firing for specified time intervals.
b) Crew log (post flight correlation of crew operation and voice comments on the EEVT).
c) As flown flight plan.

These requirements will be reflected in the Flight Operations Support Annex (PIP Annex 3).

13.0 OPTIONAL SERVICES

Planning and budget estimates of reimbursements for the payload transportation requirements and the previously cited optional services are displayed in the STS Summary Price Sheet, figure 13-1. These estimates are intended to provide preliminary information on the assumed level of cost to be borne by the SLSD and will change through more detailed definition and joint negotiations. The estimates are stated in current year dollars and the use of these estimates for planning purposes should be adjusted for inflation.

The final estimates for Standard Shuttle Services and Optional Flight System Services will be jointly negotiated between NASA Headquarters and the SLSD. Immediately prior to the initiation of the individual optional service, the performing NASA organization and the SLSD will jointly define the tasks and establish the estimated price according to the section 15 schedule for the optional service.

a) Launch site support services

14.0 PIP ANNEXES

As identified in other sections of the document, the following annexes are required:

1. Payload Data Package
2. Flight Planning
3. Flight Operations Support
6. Orbiter Crew Compartment
7. Training
8. Launch Site Support Plan

PRELIMINARY PRICE SUMMARY – PRICE PER LAUNCH – CURRENT YEAR DOLLAR ESTIMATES*

DATE PREPARED: 8/31/79

PAYLOAD IDENTIFICATION:

ELECTROPHORESIS EQUIPMENT VERIFICATION TEST (EEVT)

TOTAL ESTIMATED PRICE: $ .049 + TBD USE ($M)* + FEE

STANDARD SHUTTLE PRICE	OPTIONAL FLIGHT SYSTEM PRICE	OPTIONAL SERVICE PRICE
$ .049 USE ($M)*+FEE	$ NA USE ($M)*+FEE	$ TBD USE ($M)* + FEE

STANDARD SHUTTLE CHARGE INFORMATION

PAYLOAD CHARGEABLE WEIGHT (LBS) 90, LENGTH (IN) TBD, INCLINATION 38°, CHARGE FACTOR .002
EARNEST MONEY DATE NA, PLANNED LAUNCH DATE 2/81, NUMBER OF FLIGHTS IN SERIES 1,
B. L. S. INDEX FACTOR* 1.470 AS OF 1 June 79 :: STANDARD $ 18.0 (75$M) PLUS USE FEES $ NA

OPTIONAL FLIGHT SYSTEM INFORMATION

DESCRIPTION:

NA

PAYLOAD RELATED OPTIONAL SERVICE INFORMATION

OPTION DESCRIPTION	ESTIMATE	OPTION DESCRIPTION	ESTIMATE
a) Launch Site Support Services	TBD		

*ESTIMATES SUBJECT TO ESCALATION ACCORDING TO THE BUREAU OF LABOR STATICS (B.L.S.) INDEX AS DEFINED IN THE NASA REIMBURSEMENT POLICIES NMI 8610.8 AND NMI 8610.9; USE FEES ARE NOT SUBJECT TO ESCALATION
!!!NOTICE!!! THESE ESTIMATES ARE IN CURRENT YEAR DOLLARS. THE BILLINGS WILL BE IN FUTURE VALUE DOLLARS!!

JSC Form 692 (Rev May 79)

Figure 13-1.- Price Summary and Estimates

NASA-JSC

15.0 SCHEDULE

The attached schedule, figure 15-1, provides a summary of the various technical areas requiring data exchange and/or products in support of the EEVT/STS integration activities.

16.0 REFERENCE DOCUMENTS

a) MF0014-014 REV C - Environmental requirements and test requirements for Orbiter vehicle. (11/20/78)

b) K-STS-M-14.1 - KSC launch site accommodations handbook for STS payloads. (Current Issue)

c) NHB 1700.7 - Safety policy and requirements for payloads using STS. (Current Issue)

d) JSC 18830 - Implementation procedure for STS payload safety requirements. (May, 1979)

e) JSC 13995 - SPIDPO change control requirements and procedures manual, Rev B. (August, 1979)

f) JSC 14363 - Shuttle/payload integration activities plan.

g) JSC-07700 Volume XIV dated _____ - Space shuttle system payload accommodations.

P.E. KENNEY PHONE NO. 5923
PIP NO. JSC 14045
SPIDPO SIGNED

□ STS
▽ P/L
○ JOINT

EEVT PAYLOAD INTEGRATION

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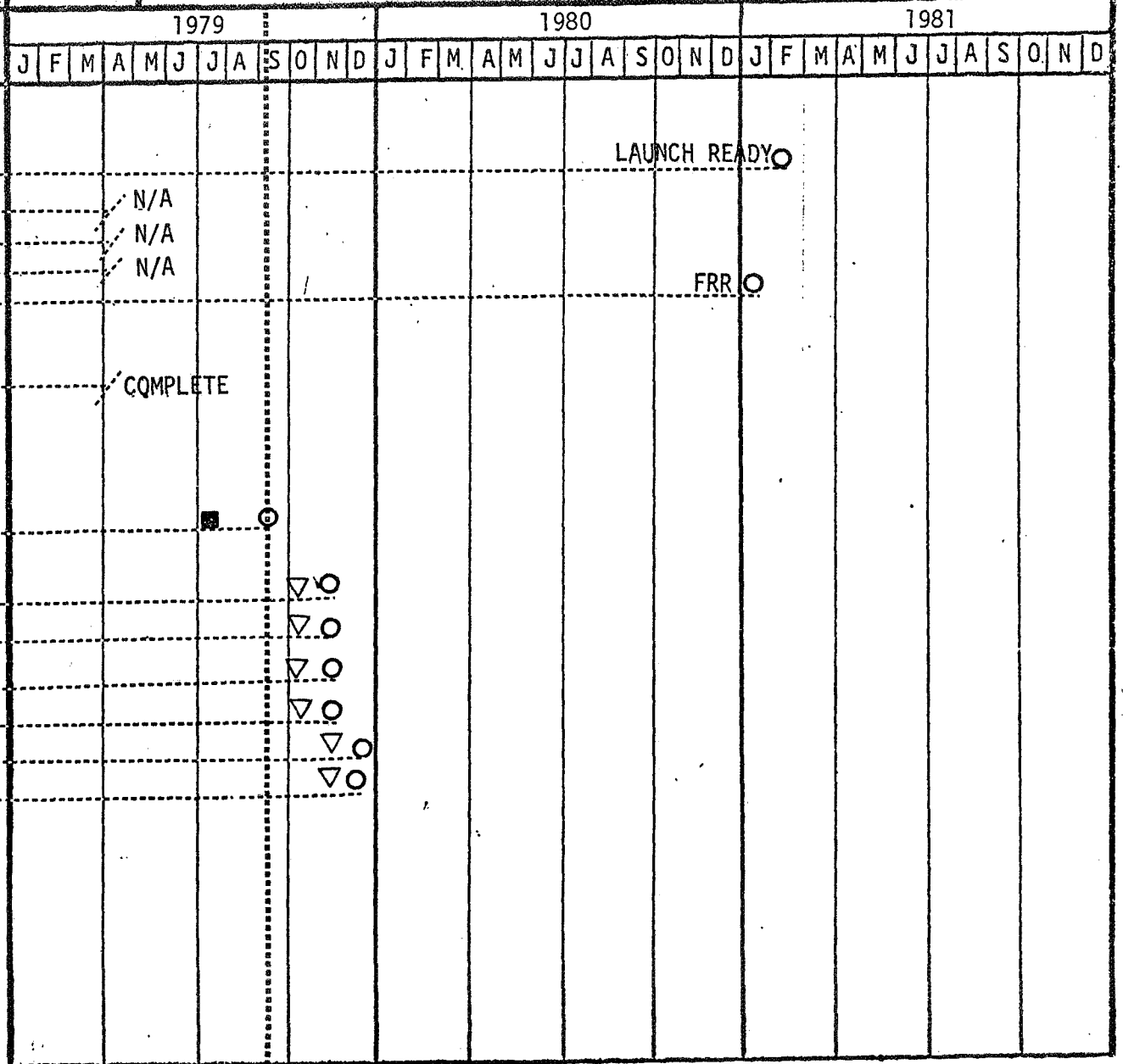

Figure 15-1.- EEVT Schedules.

P.E. KENNEY PHONE NO. 5923

PIP NO. JSC 14045

SPIDPO SIGNED

□ STS
▽ P/L
O JOINT

EEVT PAYLOAD INTEGRATION

10 SEPT, 1979 2

MILESTONES	1979 J F M A M J J A S O N D	1980 J F M A M J J A S O N D	1981 J F M A M J J A S O N D
ENGINEERING ANALYSIS/SIMILARITY			
LOADS(VCM)		▽	
THERMAL(VCM)		▽	
EMI/EMC(VCM)		▽	
SAFETY		▽ O	
HARDWARE DELIVERIES			
EEVT TO PREPACK FACILITIES		▽	
OPTIONAL SERVICES			
1. LAUNCH SITE SUPPORT SERVICES	TBD		

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NASA-JSC

Figure 15-1.- EEVT Schedules (concluded).

DISTRIBUTION LIST FOR PAYLOAD INTEGRATION PLAN JSC-14045

STANDARD DISTRIBUTION

NASA JSC
BT/W. L. Draper
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CF3/M. E. Kennedy
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CG5/J. A. Wegener
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CH6/B. L. Kyle
EA3/R. S. Sayers (2)
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EC/D. W. Morris
EE4/W. E. Perry
EH13/C. D. Levy
EH2/T. W. Eggleston
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ES/D. C. Wade
ES12/R. J. Wren
ES2/B. W. Holder
ES3/R. G. Brown
ES5/M. W. Steinthal
EW/W. W. Petynia
EW5/C. D. Perner
FA/S. D. Sanborn
FM17/L. Hartley
FM2/H. D. Beck
FM2/E. C. Lineberry
FE/S. Faber (2)
FR/J. Broadfoot
FS15/L. Croom
JM57/R. Cline (5)
JM86/Remainder
LM/A. Bishop
LT/R. Kohrs
NS2/B. J. Miller
PA/G. S. Lunney
PA/L. E. Bell
PF/L. S. Nicholson
PF/R. A. Moke
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